Living Room Baja Buggies

Written By: John Mouton

TOOLS:

- Center punch (1)
- Computer (1)
- Double-sided tape (1)
- Drill bits (1)
  To fit the rivet diameter
- Fake desert landscape (1)
- Heat-shrink tubing (1)
- Heat gun or hair dryer (1)
- Needle Nose Pliers (1)
- PICkit 2 Starter Kit (1)
  For programing
- Philips Screwdrivers (1)
  Large and small
- Rivet gun / rivets (1)
- Sandpaper (1)
- Side cutters, modeling knife, and scissors (1)
- Soldering/desoldering tools (1)
- Wire cutter/stripper (1)

PARTS:

- Wireless camera and tuner/ receiver (1)
  You need a wireless 9V DC, 300mA A/V security camera, and a 9V DC, 500mA tuner/receiver with 0.9G frequency control. Try tigerdirect.com or outpost.com, which are web warehouses with variable stock.
- VGA goggles (1)
  Any wireless-capable generic or namebrand; try amazon.com or tigerdirect.com.
- Tamiya Buggy Car Chassis Set (1)
  #70112 tamiyausa.com
- Tamiya Atomic-Tuned DC Motor (1)
  #15215
- E-Sky EK2-1003 4-channel radio system (1)
  Which includes transmitter, receiver, and 1 servomotor (mini), or similar radio system
- E-Sky EK2-0500 servomotor (1)

- hand electric drill (1)

For the camera

- Futaba FM75.470 MHz CH.64 crystal (1)
  For multiple buggies, use different crystals in the 75MHz-76MHz range to avoid cross-talk.
- Thunder Power lithium polymer (Li-Poly) 1,320mAh/7.4V, 2-cell rechargeable battery (1)
  For the motor
- 9V battery (1)
  For the camera
- Apache Smart Charger 2020 (1)
  For charging the Li-Poly batteries
- ElectriFly 2-pin male connectors (1)
  #GPMM3106, for all battery, camera, and charging connections
- Servo cable with 1 male S connector (1)
  towerhobbies. com #LXPWB5
- Male S connector (1)
  For servo cable, Tower #LXPWC3
- Ferrite ring (1)
  For radiocontrol applications, deeteeenterprises.com #K10031TA
- Battery holder (1)
  digikey.com #1294K-ND
- #42" Phillips head screw, #4 flat washers (2), and 4-40 steel hex nuts (2) (1)
  For tie rod hardware
- NOTE: (1)
  For the R/C transmitter, receiver, servos, and crystal, try hobbylobby. com and robotstore. com. For the batteries and charger, try rctoys.com and

electrify.com.

SUMMARY

Do you like radio-controlled (R/C) cars? Do you like the desert, but hate the heat? Well, sit down and kick back as you engage in the excitement of Living Room Baja Buggy Racing.

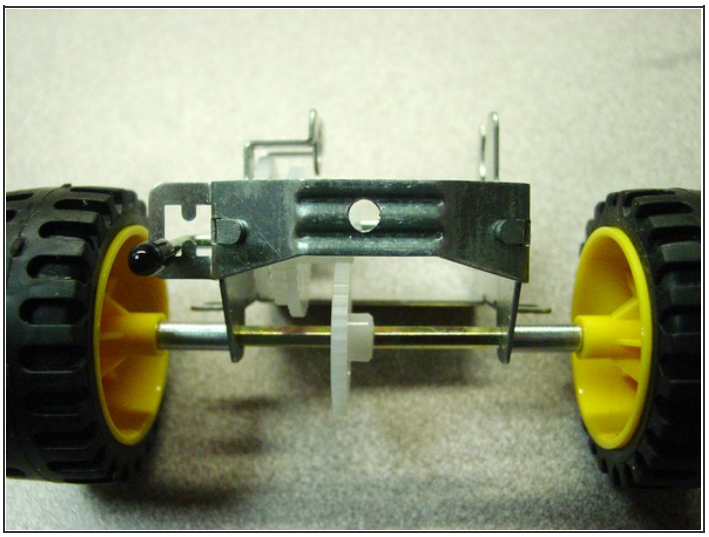
This off-road competition combines the fun of homemade R/C cars with the air-conditioned convenience of a fake, indoor desert landscape — without the big dollar price.

There are no rules, no expensive automotive racing equipment, and a total disregard for public safety (because these cars are only 6" long and 4" tall).

You don't even have to look at your car as you negotiate the terrain — an onboard camera and a virtual reality headset can be installed for your lackadaisical safety!

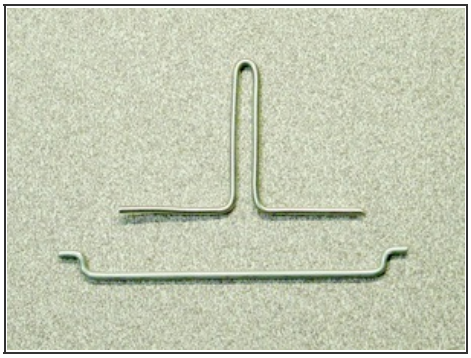
So chase the dog, race against the kids, or just put the electrons to the PC board and hold on for a bug's-eye view of the whole racecourse. It's the best thing to hit urban living since the Man Cave.

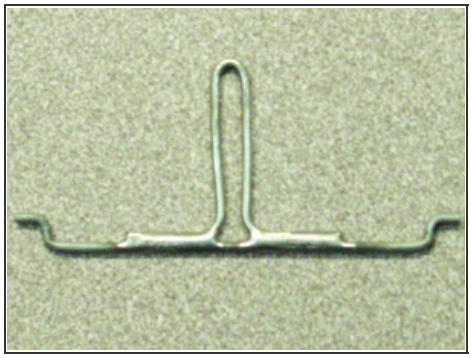
Step 1 — Build the buggy chassis.

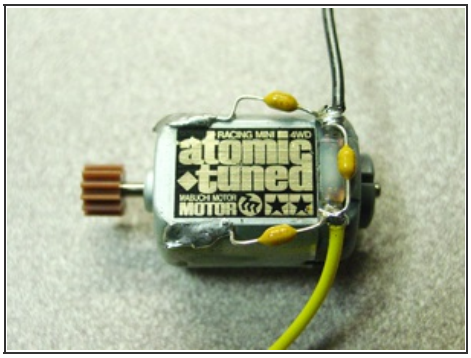


- Assemble the buggy chassis set as directed in part 3 of the instructions enclosed in the Tamiya Buggy Car Chassis Set box.
- Drill a hole in the back of the motor/gear bracket housing. You'll use it to rivet on the 9V battery holder. Use the same drill bit size as the size of your rivet.

Step 2

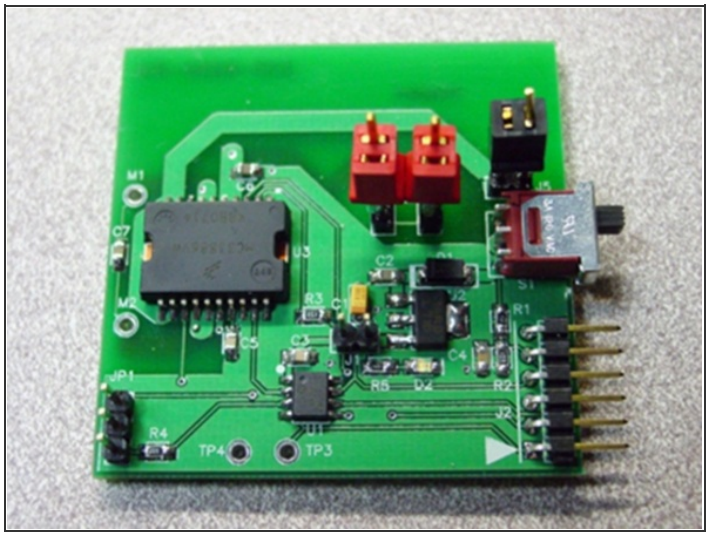


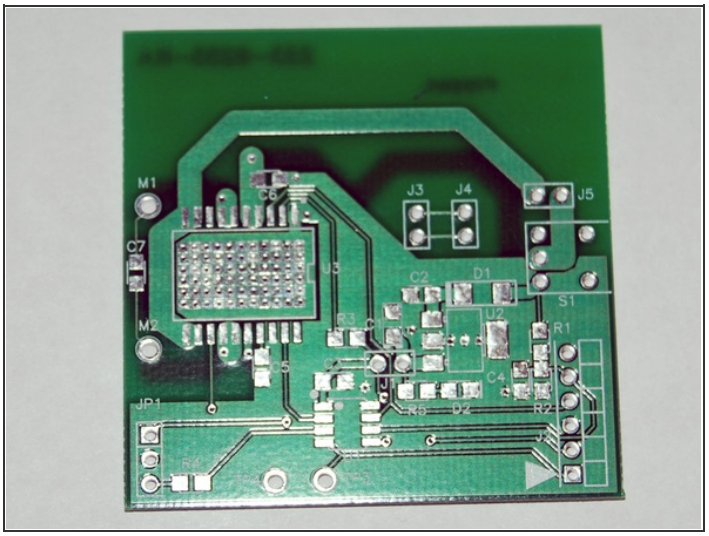




- Modify the tie rod. Bend and trim a 16-gauge wire to about 1" high with arms that fit against the tie rod provided in the buggy car chassis kit, as shown. Then solder the 2 together. This will give the servo a way to move the tie rod left, right, up, and down with the suspension, thus steering the buggy.
- Solder one 0.1-microfarad (f) capacitor and a 24-gauge wire from each lead of the atomic-tuned DC motor to the motor case. Next, solder a third 0.1 f capacitor between the leads. This will prevent electrical motor noise from interfering with the receiver circuit.
- Install the wheels as directed in part 6 of the buggy car instructions. However, don’t install the roll bar — it will just be in the way later when you install the camera servo and the motor-control circuit board.

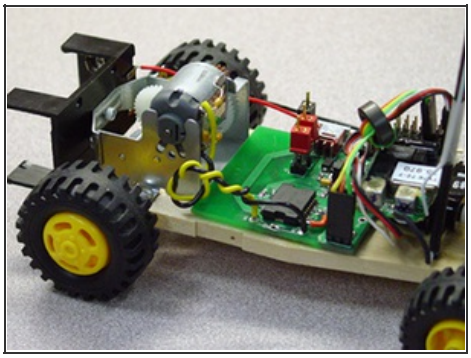
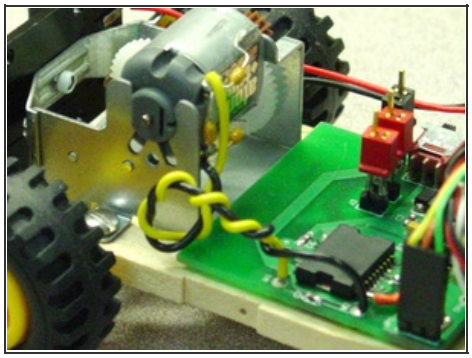
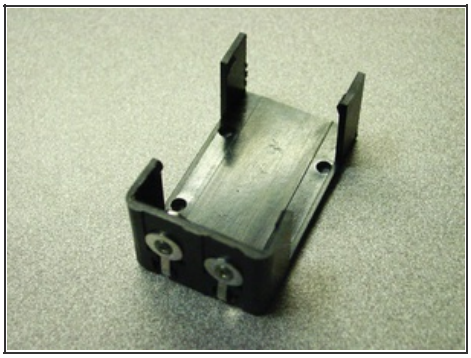
Step 3 — Build the motor-control circuit.





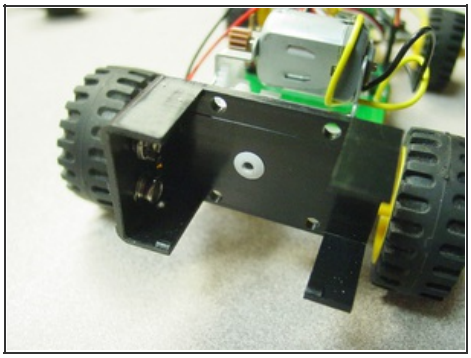
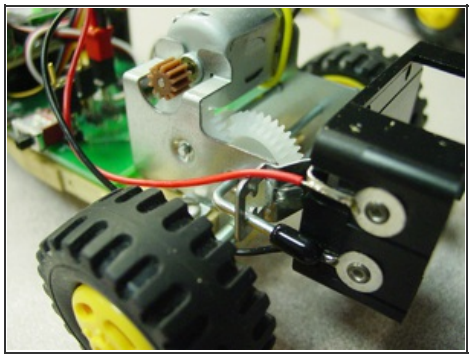
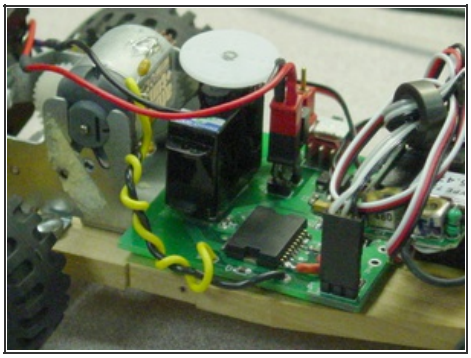
- Get a printed circuit board. I emailed the schematic and Gerber files provided at makezine.com/14/ bajabuggy to Circuit Express (circuitexpress.com). I chose their least expensive package, 10 boards for $120, and they built the boards and mailed them to me within 24 hours. Other vendors are less expensive for smaller quantities. Or you can buy a PCB build kit and make it yourself.
- Install the circuit components. All components used in the motor-control circuit can be purchased from Digi-Key (digikey.com) or any other electronic components supplier. For the battery, camera, and charger connections, I used ElectriFly 2-pin male connectors to ensure safe, secure connections. I chose the PIC12F683 MCU because it's small, has a pulse-width modulation (PWM) module onboard, and is very simple to work with. Here's what the completed circuit board should look like after all the components are soldered. Use the schematic to guide you.
- A list of components and part numbers is available at http://www.makezine.com/14/bajabuggy.

Step 4 — Install circuit board, battery holder, and servo motors.

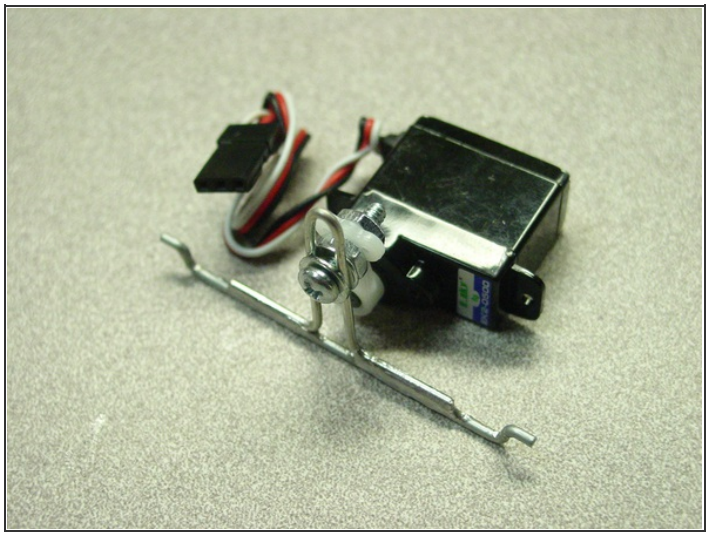
- Before you solder the motor leads, twist them around each other. This will keep electrical motor noise from interfering with the receiver. Now solder them to the circuit board at the locations marked M1 and M2.
- Use a small piece of double-sided tape to attach the circuit board to the wooden chassis, all the way back so that it touches the motor/gear bracket housing
- To install the 9V battery holder, first sand off about 5" of its bottom end. This ensures that the battery will fit flush inside, and that the holder itself will fit evenly and spaciously between the rear wheels.

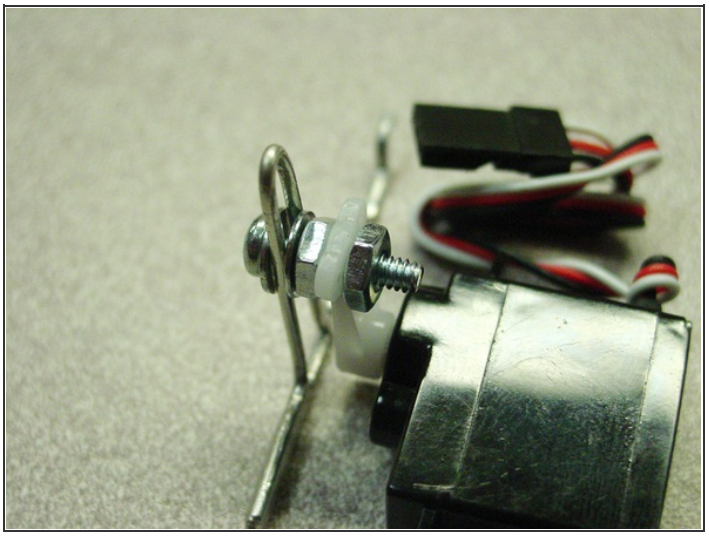
Step 5

- Drill a hole in the center of the battery holder the same diameter as the hole you drilled in the motor/gear bracket. Then rivet the battery holder to the motor/ gear bracket housing.
- Extend the battery holder's positive and negative leads by soldering 24-gauge wires to them, long enough to comfortably reach J4 on the motorcontrol circuit board. Solder a 2-pin male connector to the ends of these wires, which will allow you to disconnect the 9V camera battery from the circuit board as needed.
- Using a small piece of double-sided tape, attach 1 servomotor to the motor-control circuit board as close to the motor/gear bracket housing as possible. This servo will be used to pan the wireless camera that will be mounted on top of it.
- The servos come with an assortment of lever arms that can be attached to them, depending upon the application. Use the circular lever arm on the camera servo.

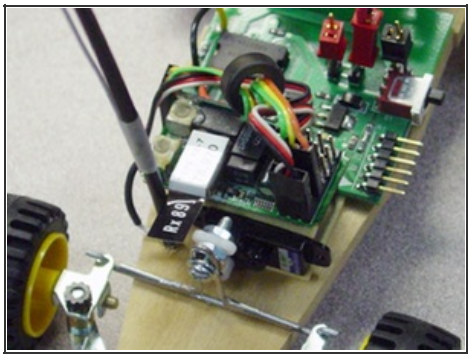
Step 6





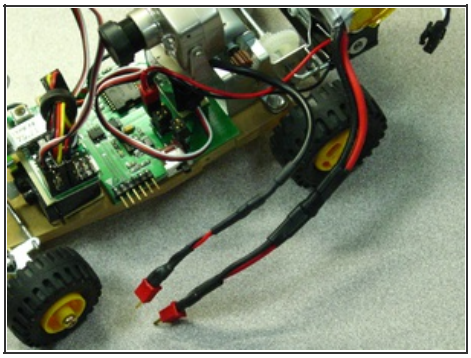
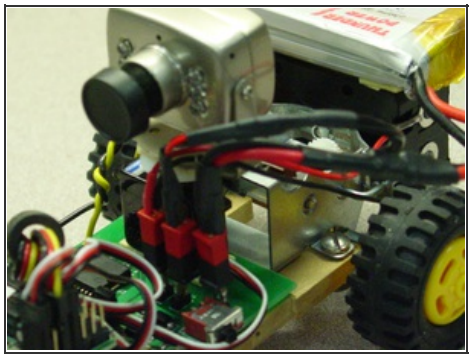
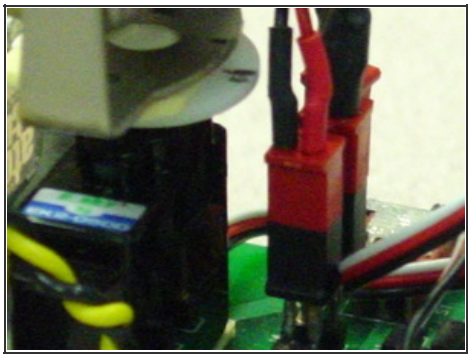
- Next, attach the other servo to the chassis just in front of the circuit board. This second servo will be used to steer the buggy.
- For the steering servo, use the straight lever arm. Drill a small hole in the lever arm the diameter of a #4 screw. Use the #4 screw, 2 washers, and two #4 nuts to loosely attach your modified tie rod to the servo lever arm. Now, as you drive the car over rough terrain, the servo will still be able to steer the front wheel even as the front suspension moves up and down.

Step 7 — Install the R/C receiver and wireless camera.



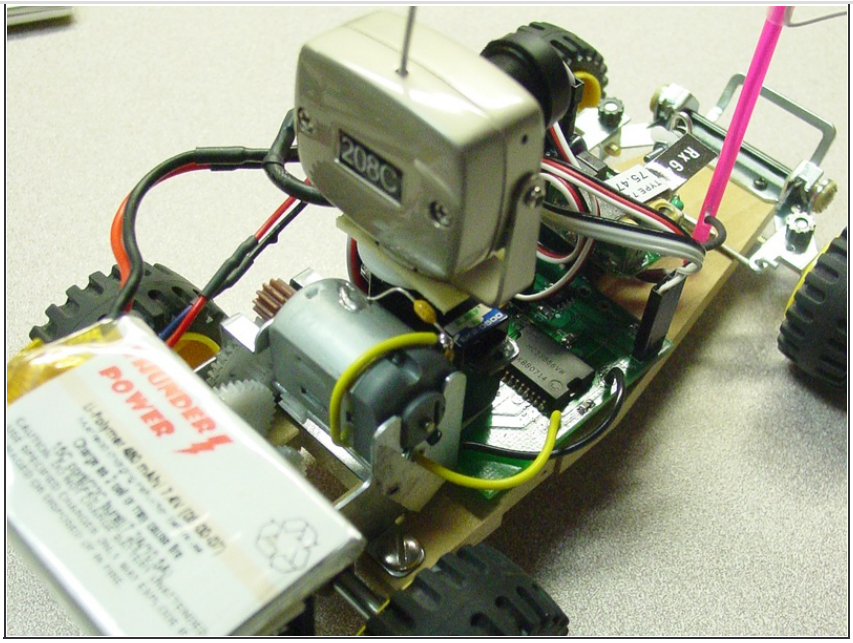
- You can use just about any R/C transmitter/receiver set for this project. If you don't already have a set, shop around for a good deal. I found a great deal on a 4-channel radio system kit that included the transmitter, receiver, and 1 servo for $60.
- The reason I chose a 4-channel dual stick transmitter (rather than a 2-channel pistol-type transmitter) is because I needed the second left-to-right stick to pan the camera.
- Using double-sided tape, attach the receiver to the top of the steering servo. To reduce the receiver's bulkiness, remove its cover. This allows you to easily install frequency crystals and plug components into the receiver.
- Plug the camera servo into channel 4, and the steering servo into channel 1. Plug connection JP1 of the motor-control circuit board into channel 3 of the receiver; this connection will supply power to the receiver and allow you to control the speed of the motor via the PWM signal generated from the PIC12F683 MCU.
- Make the PWM signal cable by crimping the male S connector's pins to the bare-wire end of the male servo cable using a pair of pliers. Now, in order to reduce electronic noise interference, loop the PWM cable through a ferrite ring before plugging it into channel 3 of the receiver. This ring will increase the cable's inductance, thereby filtering out high-frequency electronic noise.
- When using R/C transmitters and receivers for cars, keep them in the R/C car frequency range of right around 75MHz. R/C airplanes operate right around the 72MHz frequency range.

Step 8

- Before installing the wireless camera to the camera servo, shorten the camera's cable and solder another 2-pin male connector so it will plug into the motor-control circuit board at J3. To do this, cut the camera's cable down to about 3". Strip 1" of insulation and slide on a 2" piece of heat-shrink tubing. Then solder the black and red wires to the 2-pin connector, slide the heatshrink tubing over the connection, and shrink it with a heat gun or hair dryer.
- Using your double-sided tape, attach the wireless camera to the camera servo temporarily (you'll adjust it later).

Step 9 — Install the motor battery and program the PIC micro-controller.



- For the motor's power source, you need something that will supply enough voltage and last a while between charges. I used a Thunder Power lithium polymer (Li-Poly) 1,320mAh/7.4V 2-cell rechargeable battery. I don't recommend using less than a 480mAh/7.4V battery, as it would need to be recharged more often.
- The battery will have a charge even if you buy it brand-new, so keep the 2 wires from touching!
- Strip the black and red wires coming off the battery. Solder the wires to another 2-pin male connector, and heat-shrink. Attach the battery to the 9V battery holder with double-sided tape, and connect the rechargeable's wires to J5 (VBAT) on the circuit board.
- To program the PIC MCU, I used a PICkit 2 Starter Kit (#DV164120) that I bought from my company, Microchip Technology, for $50. This kit has everything you need to write, debug, and program your source code directly into the MCU via header J2 on the circuit board.
- (If you're a student or educator, visit http://microchip.com/academic to learn how you can get a discount on development tools through Microchip's Academic Program.)

Go to http://makezine.com/14/bajabuggy. All you have to do is to import the `carprogorig.hex` program file using the PICkit 2 Starter Kit interface, and then click the Program button.

Step 10 — Charge it up.

- Now that your buggy is assembled, you're almost ready to turn it on. However, you might want to charge the battery first. I used an Apache Smart Charger 2020 designed specifically for charging 2-cell Li-Poly batteries.

Step 11 — Zero the servos and set the radio controls.

- You're now ready to fire up your buggy. Once you turn on S1 on the circuit board, the servos will power up and find their neutral positions. Hence, you will need to detach the camera and reattach it so it faces toward the front of the car. (Good thing you used double-sided tape!) You may also need to make a slight adjustment to the steering servo. Simply remove the screw holding the lever arm to the servomotor, pull it off, and reattach it, pointing straight up. Now, when you turn S1 off and then turn it back on, the servos will be aligned to the correct starting points.
- With the circuit board and hand-held transmitter both turned off, adjust the transmitter toggle switches in the lower right-hand corner to set the left control stick (forward and back) as the throttle; the left control stick (left and right) for steering; and the right control stick (left and right) for panning the camera. The radio system kit's instruction manual will help you do this.
- When finished, turn the transmitter on, then turn the circuit board power on at S1. Take the throttle control stick on the transmitter and pull it all the way back toward you. Then push it all the way forward, then back to center. This will establish the maximum duty cycles for forward and reverse, and arm the speed control circuit. At this point, the buggy is ready to roll.

Step 12 — Connect the VR goggles.

- Plug the VR goggles (or a TV monitor) into the receiver that came with the wireless camera. Plug the receiver into an AC outlet. Adjust the tuning knob until a picture of what the camera sees comes up. I found that the wireless camera range is more than 500' straight line-of-sight, with no major obstacles. If you use it outside in a large open area, the range is even better.

Step 13 — Resources

- Download the Baja buggy motor control program for your PIC microcontroller, `carprogorig.hex`, as well as the Gerber files and circuit schematic from http://www.makezine.com/14/bajabuggies. You can also download an Excel file listing all the Digi-Key part numbers for components that fit this circuit board. And finally, there's a list of lower-cost build alternatives provided.
- Microchip's Online Motor Control Design Center (http://www.microchip.com/motor) has a wealth of resources for programming your PIC microcontroller to control motors and more.

This project first appeared in MAKE Volume 14, page 97.

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